PROCESS AND PLANT FOR DEHUMIDIFICATION, HEATING AND INJECTION MOULDING OF GRANULATED PLATSTICS MATERIALS

Description

Technical field

The present invention relates to a process of dehumidification and of injection and moulding for granulated plastics materials according to the characteristics set forth in the preamble to independent Claim 1. The invention is also directed towards a plant arranged to operate in accordance with the process, according to the preamble to independent Claim 10.

Technological background

In the field of methods for the processing of granulated plastics materials by injection and moulding, it is known that the granules have to reach the injection and moulding press with a moisture level which is as low as possible (or in any case is controlled in dependence on the type of final product to be produced). For this purpose, the granules are normally subjected to a dehumidification step immediately upstream of the injection and moulding step.

This requirement is particularly necessary for plastics materials which have a high hygroscopic capacity such as, for example, polyethylene terephthalate (PET), to the processing of which the present invention is preferably but not exclusively applied.

In known processes, the step of dehumidification of the granules is carried out in a hopper by stripping of the moisture contained in the

granules with air which is caused to flow as a counter-current. To promote the dehumidification process, the air admitted to the hopper (process air) has an extremely low moisture content and a relatively high temperature.

With regard to this latter characteristic, the need is known to maintain the temperature as high as possible, not only in view of possible improvements in terms of the drying of the granules but also in view of a reduction in the cycle times of the injection and moulding press which is typically disposed immediately downstream of the dehumidification step.

In this apparatus, in fact, before the granules are injected into the mould, they have to be brought to the melting point of the polymer in a suitable heating chamber, requiring a certain amount of time which forms part of the overall cycle time of the press.

The increase in temperature within the dehumidification step is limited, however, by the fact that high temperature promotes undesired oxidative degradation reactions of the polymer, compromising the final quality of the product.

It is therefore necessary to carry out the dehumidification process at a temperature adapted to the conflicting requirements for quick and effective drying of the granules and for maintenance of the qualitative integrity of the polymer.

A range of temperature values which is normally used as an optimal compromise between the requirements set out above is between 180°C and 190°C. At these temperatures, the PET granules are

supplied to the injection and moulding apparatus which brings them to a temperature of about 280°C - 290°C, ready to be injected into the mould.

Description of the invention

The problem underlying the present invention is that of providing a process of dehumidification and of injection and moulding for granulated plastics materials, as well as a plant arranged to operate in accordance with the process, which are designed structurally and functionally to respond to the requirements set out above, overcoming the limitations of the prior art mentioned.

This problem is solved by the present invention by means of a process of dehumidification and of injection and moulding, as well as a plant operating in accordance with the process, according to the appended claims.

Brief description of the drawings

The characteristics and the advantages of the invention will become clearer from the detailed description of a preferred embodiment thereof which is described by way of non-limiting example with reference to the appended drawing in which the sole Figure 1 is a schematic view of a plant for the dehumidification and the injection and moulding of granulated plastics materials, arranged to operate in accordance with the process of the present invention.

In the appended drawing, a plant for the dehumidification of granulated plastics materials and for the injection and moulding thereof, formed in accordance with the present invention, is generally indicated

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In the preferred embodiment described herein, the plant 1 is intended for the dehumidification of polyethylene terephthalate (PET) granules and comprises, as a whole, a dehumidification unit 1a for dehumidifying the granules, and an injection and moulding unit 1b disposed downstream of the dehumidification unit 1a.

The dehumidification unit 1a in turn comprises a hopper 2, a granule-loading system 3 for loading the granules into the hopper 2, as well as a circuit 4 for the admission and treatment of the process air for removing moisture from the granules inside the hopper 2.

The hopper 2 is loaded with granules from above by means of the loading system 3 which comprises a suction line 5 for the pneumatic transportation of the granules. The suction line 5 opens at a first end in a granule storage tank 6 and is connected to a cyclone 7, which is disposed at the top of the hopper 2 and in which the granules are separated from the transportation air and are allowed to fall into the hopper, and then to a vacuum pump 8.

Inside the hopper 2, the granules come into contact with process air which is admitted from the bottom 2a of the hopper 2 as a counter-current relative to the granules, at a dehumidification temperature.

The process-air admission and treatment circuit 4 comprises a dehumidifier 10, for example, of the type with molecular sieves, which is connected downstream to a heater 11 and then to a line 12 for admitting the air to the hopper 2. The circuit 4 is completed by a line 13 for recovering the process air from the hopper; the line 13 connects the

top of the hopper 2 to a pair of filters 14 and then to a heat recovery unit 15 and finally to the dehumidifier 10.

The operation of the dehumidifier 10 is controlled by a control unit 16.

The above-mentioned components are dimensioned and controlled in accordance with procedures known in the technical field in question and will not therefore be described in greater detail.

The bottom 2a of the hopper 2 is connected downstream to the injection and moulding unit 1b which comprises, for example, an injection and moulding press arranged for the manufacture of PET-based articles or semi-finished products.

The injection and moulding press in turn comprises a heating chamber for bringing the granules to a moulding temperature which, in the case of PET, is between 280°C and 290°C, and a mould into which the molten plastics material is admitted. These presses are also known in the technical field in question and a detailed description thereof will therefore be omitted.

According to a principal characteristic of the invention, granule-heating means, generally indicated 20, are interposed between the dehumidification unit 1a and the injection and moulding unit 1b.

The granule-heating means 20 comprise a hopper 21 and a circuit 22 for the heating and admission of a hot gas into the hopper 21 in order to heat the granules contained therein to a supply temperature for supply to the injection and moulding unit.

The hopper 21 is connected at its top to the bottom of the hopper

2 by means of a duct 23 and at its bottom to the injection and moulding unit 1b by means of a duct 24 and is preferably provided with stirring means 21b for keeping the granules inside it in motion.

The circuit 22 comprises gas-movement means, for example, a blower 25 which is connected by means of a line 26 to a heater 27, preferably of an electric type, and to the bottom 21a of the hopper 21, where the gas is put in contact with the granules, flowing as a counter-current relative thereto, towards the top of the hopper 21. From there, the gas is led back to the blower 25 by means of the return line 28, after passing through a filter 29.

The gas used in the circuit 22 is a substantially oxygen-free gas, that term being intended to indicate generally a presence of less than about 5% of oxygen. The gas is preferably technical nitrogen and can be introduced into the circuit 22, for example for operations for the replenishment thereof, by means of a coupling 30 provided in the line 26.

The granule-heating means 20 further comprise a control unit 35 which is arranged for the control and overall management of that step of the process, as described in greater detail in the following paragraphs.

The process according to the present invention comprises a first step for the dehumidification of the granules with process air. The granules are loaded into the hopper 2 at the top thereof by means of the loading system 3 and the process air is admitted from the bottom 2a as a counter-current, at a temperature such that the granules inside the hopper are at a dehumidification temperature of between 180°C and

190°C. The process air output from the hopper 2 preheats the process air output from the dehumidifier 10 in the heat recovery unit 15 and is sent to the dehumidifier 10 in order to be treated in the molecular sieves thereof. At the output from the dehumidifier 10, the process air has a very low moisture level with a dew point typically of between -50°C and -60°C.

Before the process air is admitted to the hopper 2, it is then preheated in the heat recovery unit 15 and is brought to the final temperature by the heater 11.

The granules are then supplied, by falling through the duct 23, into the hopper 21 where they are heated by contact with the gas admitted through the circuit 22 to a supply temperature between the dehumidification temperature and the moulding temperature.

The granules are preferably brought to a supply temperature of between 200°C and 250°C, even more preferably between 220°C and 230°C.

It should be noted that the granules are heated to a supply temperature lower than the softening point of the granules which, for PET, is of the order of 270°C, so as not to create problems when they pass from the hopper 21 to the injection and moulding press due to sticking of the granules. In any case, the mixing to which the granules are subjected by virtue of the action of the stirring means 21b is such as to prevent the establishment of local hot spots which could lead to the above-mentioned sticking problems.

The granule-heating means 20 are of dimensions such that the

granules remain in the hopper 21 for sufficient time to reach the supply temperature indicated above.

Granules are thus supplied to the injection and moulding unit at a higher temperature and the unit thus requires less time to bring them to the moulding temperature.

The heating step thus promotes the process of the plasticization of the granules within the injection and moulding press, also leading to less thermal degradation of the PET and a lower energy consumption for the operation of the press.

As stated above, the gas is preferably technical nitrogen. It is found that undesired degradation reactions of the PET are thus not triggered, in spite of the high temperature reached.

Although the use of technical nitrogen remains the greatly preferred option, the gas may be constituted by air with a low oxygen content. The gas may even result from the use, in closed circuit for a suitable period of time, of process air drawn from the circuit 4 (variant shown in Figure 1 by means of the discontinuous connecting line 31). If the process air is recirculated continuously in the hopper 21, the fraction of oxygen therein will in fact reduce over time because of oxidative reactions with the plastics material present therein until it reaches the percentages indicated above which enable further possible degradation reactions to be prevented. Naturally, during this recirculation stage in which the oxygen fraction is still high, a lower temperature of the gas will have to be maintained unless a generally lower quality of the granules output from the hopper 21 is acceptable.

The present invention thus solves the problem discussed above with reference to the prior art mentioned, at the same time offering many further advantages, amongst which is an increase in the productivity of the dehumidification and injection and moulding plants without compromising the quality of the final product.

Another advantage is that operation in an environment that is substantially free of oxygen also minimizes degradative reactions which might lead to the undesired formation of aldehydes, particularly formaldehyde and acetaldehyde which, with their strong and pungent odours, can adversely affect the flavour of any beverage contained in bottles produced from the granules of plastics material.